

# **Bear River Greenbelt Survey 2011**

*By Little Traverse Bay Bands of Odawa Indians and  
Tip of the Mitt Watershed Council*

Survey performed by:  
Jacqueline Pilette (LTBB) and  
Kevin L. Cronk (TOMWC)

Report written by:  
Kevin L. Cronk

## Table of Contents

	Page
<b>List of Tables and Figures</b> .....	<b>iii</b>
<b>Summary</b> .....	<b>1</b>
<b>Introduction</b> .....	<b>2</b>
Background .....	2
Study Area .....	4
<b>Methods</b> .....	<b>7</b>
Field Survey .....	7
Data processing .....	7
<b>Results</b> .....	<b>9</b>
<b>Discussion</b> .....	<b>12</b>
Recommendations .....	14
<b>Literature and Data Referenced</b> .....	<b>16</b>
Appendix A: Streambank erosion assessment field form .....	17

## List of Tables

	Page
Table 1. Bear River Watershed land-cover statistics.....	4
Table 2. Greenbelt assessment results.....	9
Table 3. Streambank erosion survey results.....	9

## List of Figures

	Page
Figure 1. The Bear River Watershed.....	5
Figure 2. Land Cover 2006 in the Bear River Watershed.....	6
Figure 3. Bear River greenbelt and erosion survey results.....	10
Figure 4. Bear River greenbelt and erosion survey results: lower section.....	11

## SUMMARY

Riverfront property development and recreational use often has negative impacts on the stream ecosystem, including the loss of streambank vegetation (i.e., greenbelts), accelerated streambank erosion, and the spread of invasive species. The Little Traverse Bay Bands of Odawa Indians (LTBB) collaborated with Tip of the Mitt Watershed Council (TOMWC) to comprehensively survey the main branch of the Bear River to assess the riparian corridor in terms of greenbelts, erosion, and invasive species. Funding for the project was provided by a grant obtained by LTBB from the United States Environmental Protection Agency's Great Lakes Restoration Initiative (GLRI).

During the late summer and early fall of 2011, LTBB and TOMWC assessed greenbelt health, documented erosion, and noted invasive species for every property on the main branch of the Bear River from Walloon Lake to Little Traverse Bay. Survey results show that the riparian corridor of the Bear River is in good shape; nearly 90% of properties had excellent greenbelts, there were only three areas of severe erosion, and most of the harmful invasive species were uncommon.

Despite the relatively pristine nature of the Bear River, there is room for improvement. The negative impacts associated with native riparian vegetation removal and turf grass installation on riverfront parcels can be moderated by establishing a no-mow buffer zone or restoring native vegetation by planting herbaceous and woody native plants. Most areas with eroding streambanks that are contributing sediments and nutrients to the river could be remediated without incurring excessive costs. Controlling the spread of most of the harmful invasive species documented during the survey can be done effectively and affordably because occurrences are limited.

Regulation can be an effective approach for protecting shoreline greenbelts. Melrose and Bear Creek Townships have adequate ordinances in place to protect greenbelts on the Bear River. However, the City of Petoskey does not require that a vegetated buffer strip be maintained on lake and stream shorelines. Survey results show that all properties with poor greenbelts and severe erosion were located in the City of Petoskey.

Follow-up activities are recommended to get the maximum value out of this survey. LTBB and TOMWC are working together to get survey results out to Bear River property owners, local governments, and the general public. This outreach effort is intended to increase understanding of the ecological value of the riparian corridor, provide information for improvements, and highlight the effectiveness of water protection ordinances. The goal of follow-up activities is to improve the health of greenbelts, reduce erosion, and control the spread of invasive species in the Bear River Watershed, which will help protect the stream ecosystem and improve water quality.

## INTRODUCTION

### **Background:**

During the late summer and early fall of 2011, a survey was conducted by the Little Traverse Bay Bands of Odawa Indians (LTBB) and Tip of the Mitt Watershed Council (TOMWC) to evaluate the health of greenbelts, assess eroding streambanks, and note invasive species along the banks of the Bear River. All riverfront properties on the main branch of the Bear River from Walloon Lake to Little Traverse Bay were assessed. LTBB acquired funding for the survey through the U.S. Environmental Protection Agency's Great Lakes Restoration Initiative (GLRI).

Greenbelts refer to the vegetated areas along the shoreline of lakes, ponds, rivers and streams. Greenbelts may have a natural look with a mix of different species and plant types, or may have a more landscaped or formal appearance consisting of a few select species. Most Northern Michigan rivers and streams contain undeveloped areas where healthy, natural greenbelts predominate. However, riparian development pressure has increased over time, resulting in fewer riverfront properties with healthy greenbelts.

Streambank erosion occurs naturally in river systems, but can be accelerated due to human actions in the watershed. Streambank erosion contributes sediments and nutrients to the river, which, when excessive, has negative impacts on the stream ecosystem. Sediments smother fish spawning beds, clog gills of fish and invertebrates, elevate water temperatures, and reduce habitat by filling interstitial spaces between gravel, cobble, and rocks.

Invasive species are non-indigenous species that create an ecosystem disruption or causes harm to the environment when introduced, which varies in terms of the type of disruption or harm caused and the severity. The introduction of an invasive species can lead to localized loss of native species, alter fundamental ecosystem processes (e.g. nutrient cycle disruptions caused by zebra mussels), and even cause hydrological changes (e.g., water table changes due to dense invasive *Phragmites* infestations). Some of the most harmful invasive species in Northern Michigan include invasive *Phragmites* (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Fallopia japonica*), Giant knotweed (*Polygonum sachalinense*), black swallowwort (*Cynanchum louiseae*), and invasive buckthorn (*Rhamnus cathartica* and *Rhamnus frangula*).

Riparian surveys must be conducted periodically to adequately monitor the continually changing conditions of the stream ecosystem. Many changes are a result of human actions within the riparian corridor and the watershed. The Bear River was comprehensively assessed for streambank erosion and in-stream habitat in 2000 and 2001 by Watershed Council staff and volunteers (TOMWC 2005). This assessment

included an inventory of 47 road-stream crossings in the watershed. In 2005 and 2007, the Watershed Council performed follow-up surveys to reassess streambank erosion in the Bear River. In 2010, the Watershed Council surveyed the entire main branch of the Bear River for the presence of purple loosestrife and common reed, or invasive *Phragmites* (TOMWC 2010). Based on these inventories and assessments, several restoration projects have been carried out to address streambank erosion and inadequate or failing culverts at road-stream crossings. Greenbelt health for Bear River riverfront properties was not comprehensively assessed during these surveys.

The 2011 survey consisted of a comprehensive assessment of all riverfront properties, thereby providing consistent data for the entire main branch of the Bear River. This valuable dataset has immediate utility as a river management tool and, in the future, for determining and assessing trends. Through follow-up activities, such as distributing educational brochures, offering on-site consultations, holding educational workshops, correcting streambank erosion, and implementing invasive species control measures, the health of the riparian corridor can be protected and improved. Regularly updating (repeating) the survey will provide the necessary information to determine long-term trends and identify streambank areas that require remedial action.

It is noteworthy to highlight that the Bear River is within the Little Traverse Bay Watershed, and as such, is included in the EPA/MDEQ-approved Little Traverse Bay Watershed Protection Plan (Plan) (2007). The Plan includes goals, objectives, and recommended implementation steps for protecting water quality within the watershed. The Bear River Greenbelt Survey (2011) works toward achieving the following goals of the Plan:

- Goal: Improve and maintain navigation in the Bear River and other tributaries by reducing sediment inputs.
- Goal: Improve warm water fishery by reducing inputs of toxic substances, sediments and nutrients, and controlling aquatic invasive species.

Furthermore, the recommendations made in this report are consistent with the following recommended implementation steps of the Plan:

- Develop a hand-out on riverfront living and distribute to river and stream riparians.
- Inventory riparian corridor of the tributaries to assess health, diversity, and density of vegetation.
- Repair most severe lakeshore and streambank erosion sites.
- Monitor for the presence of invasive species and work to control purple loosestrife, Eurasian watermilfoil, and other species that impair aquatic habitat.
- Work with local government to provide better zoning tools to help protect water quality (e.g. documenting greenbelt conditions, ordinance language).

**Study area:**

The Bear River is located in the northwest Lower Peninsula of Michigan; draining portions of Bear Creek, Resort, and Springvale Townships in Emmet County and Bay, Boyne Valley, Chandler, Evangeline, Hudson, and Melrose Townships in Charlevoix County. The main branch of the river drains 4,600-acre Walloon Lake on the west side of the watershed, flowing 14.5 miles to Little Traverse Bay (Figure 1). The major tributaries include Springbrook Creek, which drains the Chandler Hills in the southeast portion of the watershed, and Hay Marsh Creek, which drains an area in the southwest part of the watershed between Walloon Lake Village and Boyne Falls.

The Bear River Watershed drains approximately 74,215 acres of land and water. Based on 2006 remote sensing data from the Coastal Great Lakes Land Cover project, landcover in the watershed is mostly natural with 49% forested and 18% wetland (Table 1 and Figure 2). Agricultural and urban landcover account for 18% of the watershed area; they increased by a combined 1.6% between 2000 and 2006.

**Table 1.** Bear River Watershed land-cover statistics.

Land Cover Type	2000 Acreage*	2000 Percent*	2006 Acreage*	2006 Percent*	Change (%)
Agriculture	10199.96	13.73	10625.43	14.31	0.57
Barren	157.79	0.21	169.06	0.23	0.02
Forested	35557.38	47.88	36213.36	48.76	0.88
Grassland	7314.87	9.85	4629.60	6.23	-3.62
Scrub/shrub	1410.95	1.90	1645.73	2.22	0.32
Urban	2045.96	2.76	2821.68	3.80	1.04
Water	4823.54	6.50	4727.00	6.37	-0.13
Wetland	12752.60	17.17	13431.20	18.09	0.91
TOTAL	74263.05	100.00	74263.05	100.00	NA

*\*Land-cover data from the NOAA Coastal Change Analysis Program.*

Water quality monitoring information for the Bear River was compiled in a summary report written by the Watershed Council (TOMWC 2010). Water quality data have been collected from the Bear River and its tributaries over the last several decades and are available through the Michigan Department of Environmental Quality (MDEQ), Tip of the Mitt Watershed Council (TOMWC), and Little Traverse Bay Bands of Odawa Indians (LTBB). Physical, chemical, and biological water quality data are available for multiple sites on the river, as well as Springbrook and Hay Marsh Creeks.

Nearly 40 years of water quality data from the Bear River Watershed show some changes, but that water quality remains high and the stream ecosystem relatively healthy. This is not surprising because the Bear River Watershed remains relatively undeveloped. Furthermore, with its excellent water quality, Walloon Lake supplies water to and essentially forms the main channel of the river.

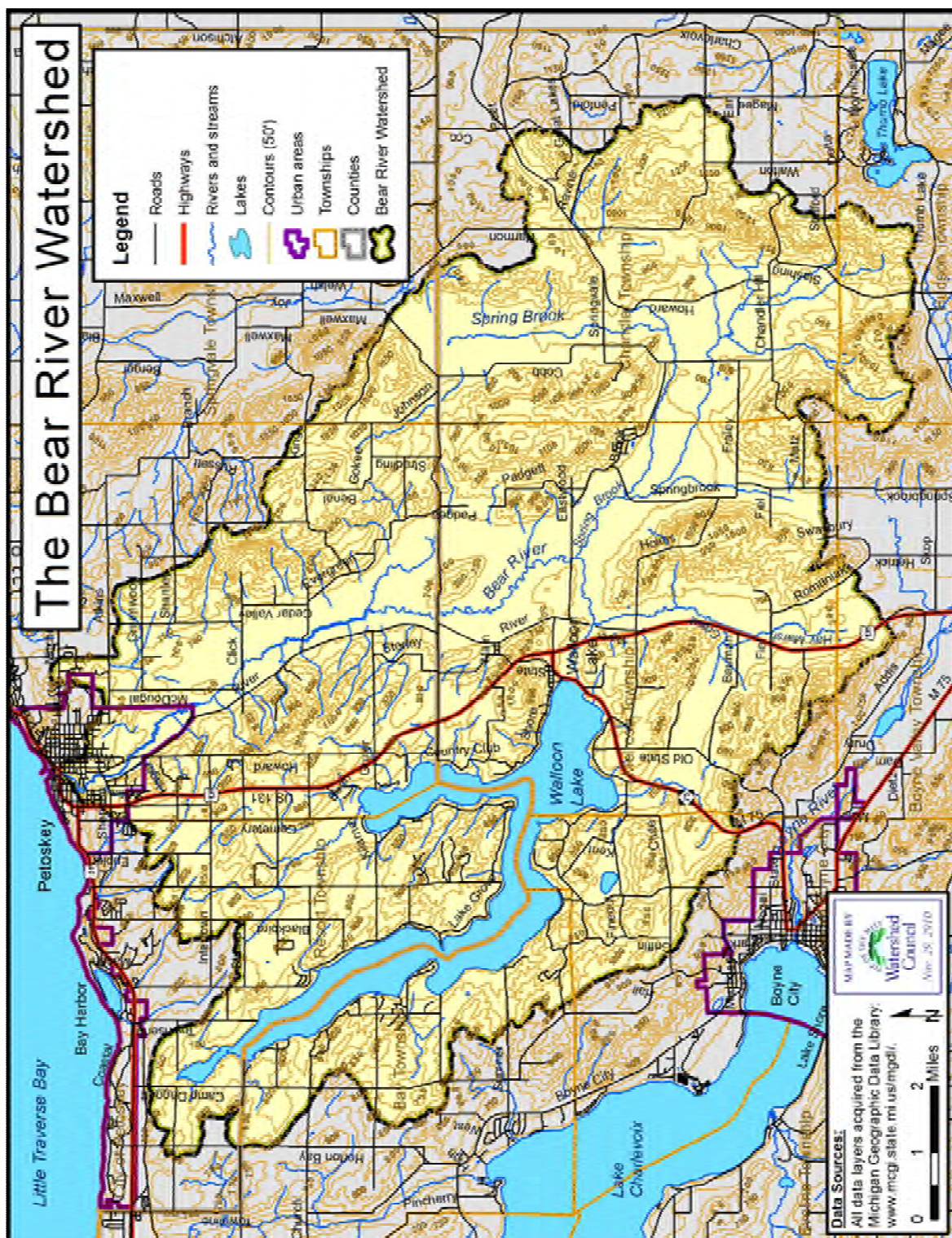


Figure 1. The Bear River Watershed.



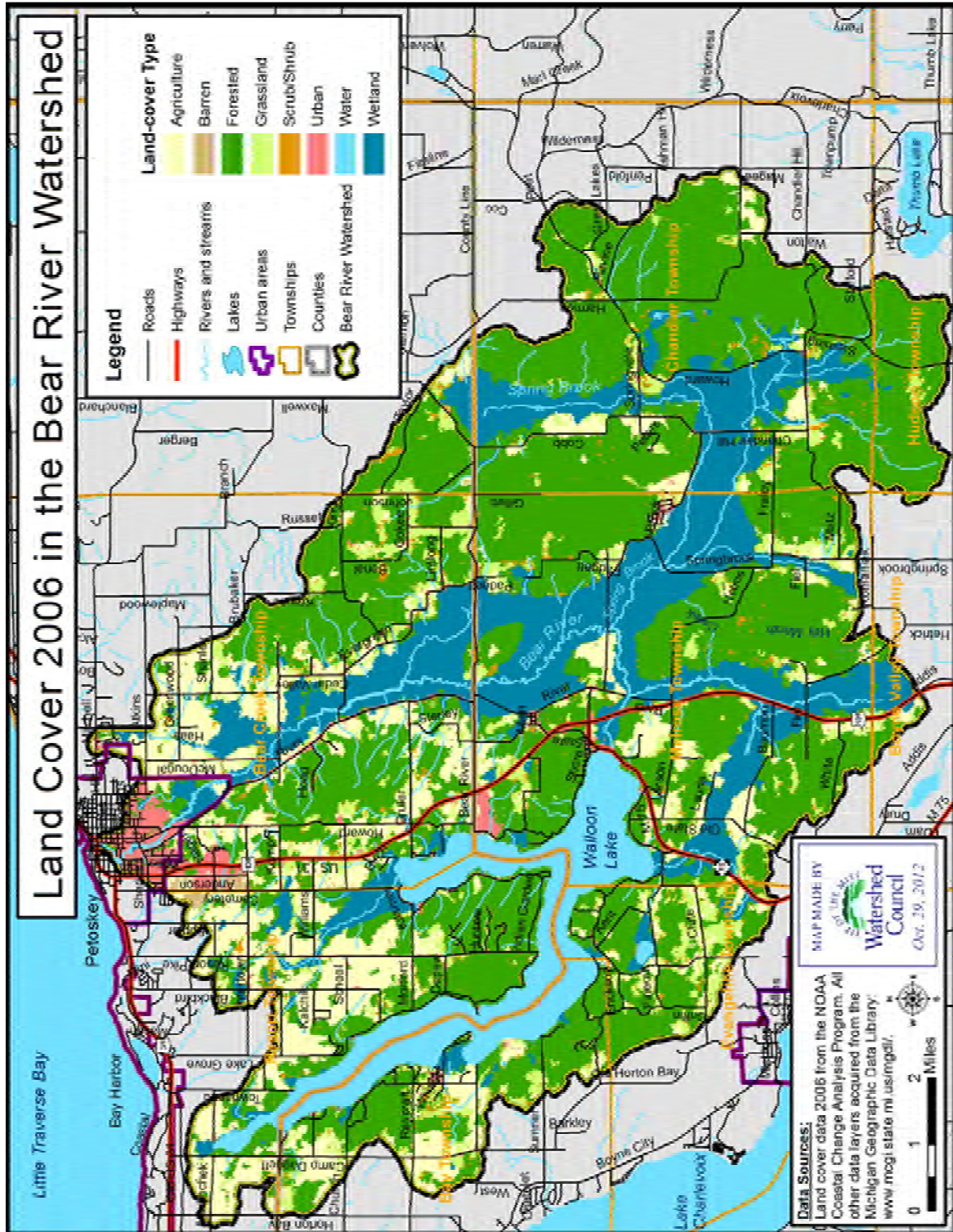


Figure 2. Land Cover 2006 in the Bear River Watershed.

## METHODS

### Field Survey:

The main channel of the Bear River was surveyed during the late summer and early fall of 2011 to document and assess greenbelts on riverfront properties. Every riverfront property was assessed from kayak in terms of greenbelt health, streambank erosion, and the presence of invasive species. Information for each property was recorded on field datasheets. In addition, a GPS camera was used for photographic documentation of all riverfront properties.

Greenbelts for riverfront properties were rated based on the percentage of on the amount of intact streambank vegetation. Properties with at least 75% of their riparian vegetation intact were considered to have good greenbelts and received an “excellent” rating. Properties missing between ~50%-75% of their streambank vegetation received a “moderate” rating and properties with more than 50% of the greenbelt missing were assigned a “poor” rating. Greenbelt ratings were determined using information from Ricoh and Lumix GPS camera photos as well as 2011 field survey notes taken by the LTBB Project Coordinator and TOMWC staff.

Information about streambank areas experiencing erosion was recorded on an assessment field form developed by the Watershed Council (Appendix A). The field form includes sections to provide details about 1) location, 2) site information, 3) condition of the bank, 4) apparent cause of bank erosion, 5) amount of erosion and slope ratio, 6) river conditions, and 7) type of treatment recommended. The overall severity rating of “severe”, “moderate”, or “minor” was determined for each erosion site using information from field form sections #3 and #5. Field notes and photographs were also used in rating determinations.

Invasive species were recorded as observed during the survey for individual properties along the Bear River. Although many different invasive species were noted during the survey, outreach and control efforts associated with this project focused on only those listed as “harmful invasive species” in the Bear River Watershed Invasive Species Management Plan (black swallowwort, Japanese knotweed, giant knotweed, invasive *Phragmites australis*, invasive buckthorn, purple loosestrife). The harmful invasive species noted in the field were included in the GIS layer developed to present survey findings.

### Data Processing:

County equalization GIS data were used to develop a GIS data layer of all riparian properties on the main branch of the Bear River. Each property in the GIS layer was assigned a unique number that follows the river sequentially downstream from Walloon Lake to the mouth, which is included in a new attribute column: “TOMWC\_ID11”.

Greenbelt ratings, streambank erosion severity ratings, select information from streambank erosion data forms, and harmful invasive species were inputted into an Excel® workbook for all riverfront properties. The workbook was joined to the GIS data layer of riparian properties to create a new GIS data layer containing both county equalization information and field survey data. Digital GPS photographs taken during the survey were uploaded to a computer and processed to facilitate review of streambank conditions and used to develop a GIS point layer that included locations of all streambank erosion. Final products include a comprehensive database, a complete set of GPS digital photographs, a GIS polygon layer of riverfront parcels that include both county equalization and shore survey data, a GIS point layer of streambank erosion locations, and a map displaying results.

## RESULTS

This survey documented greenbelt status, erosion, and invasive species at 95 riverfront parcels on the main branch of the Bear River. The length of streambank per parcel varied from approximately 50 feet to more than a mile. Along the main branch, 48 parcels (51%) are held in private ownership. The remaining 47 parcels are owned by state agencies, local governments, and educational institutions.

The survey found that a strong majority of riparian greenbelts on the Bear River are in excellent condition. Nearly 90% of riparian properties were in pristine or nearly perfect condition, ranking in the excellent category (Table 2). Only three properties were found to have poor greenbelts and five fell into the moderate category. Poor greenbelts were only found at the mouth of the river (Figure 2).

**Table 2.** Greenbelt assessment results.

<b>Greenbelt Rating*</b>	<b>No. of parcels</b>	<b>% of parcels</b>
Excellent	85	89.47
Moderate	5	5.26
Poor	3	3.16
No data	2	2.11

*\*Poor signifies that >50% of the greenbelt has been removed, moderate 25-50%, and excellent <25%.*

Streambank erosion was documented at 57 locations during the 2011 survey on a total of 22 properties. Of these properties, nine were privately owned and 13 publicly owned. Over 75% of riverfront properties had no erosion (Table 3). Less than 10 properties had severe or moderate erosion. Locations of erosion were concentrated in the lower section of the river (Figure 2).

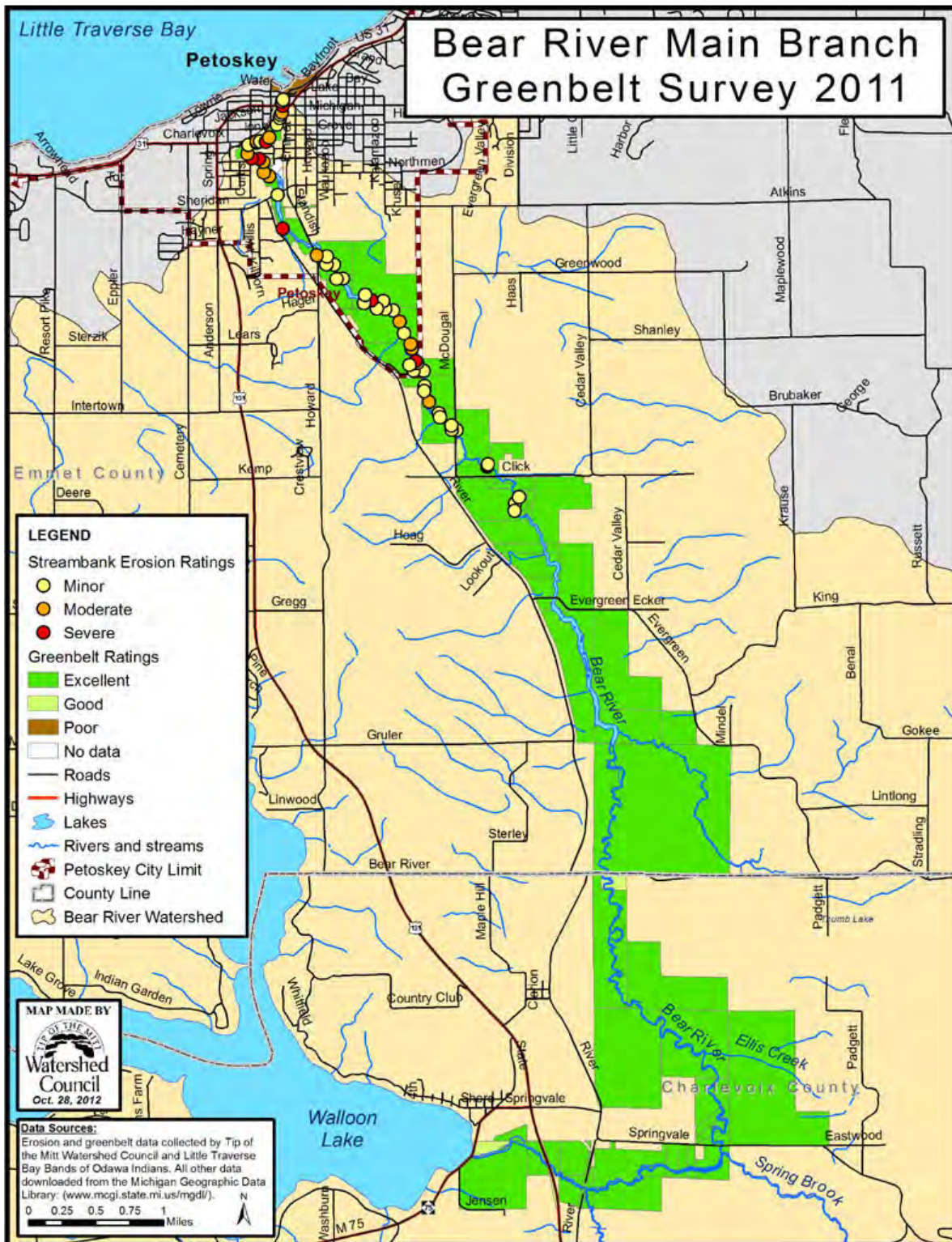
**Table 3.** Streambank erosion survey results.

<b>Erosion Rating*</b>	<b>No. of parcels</b>	<b>% of parcels</b>
No erosion	73	76.84
Minor	13	13.68
Moderate	6	6.32
Severe	3	3.16

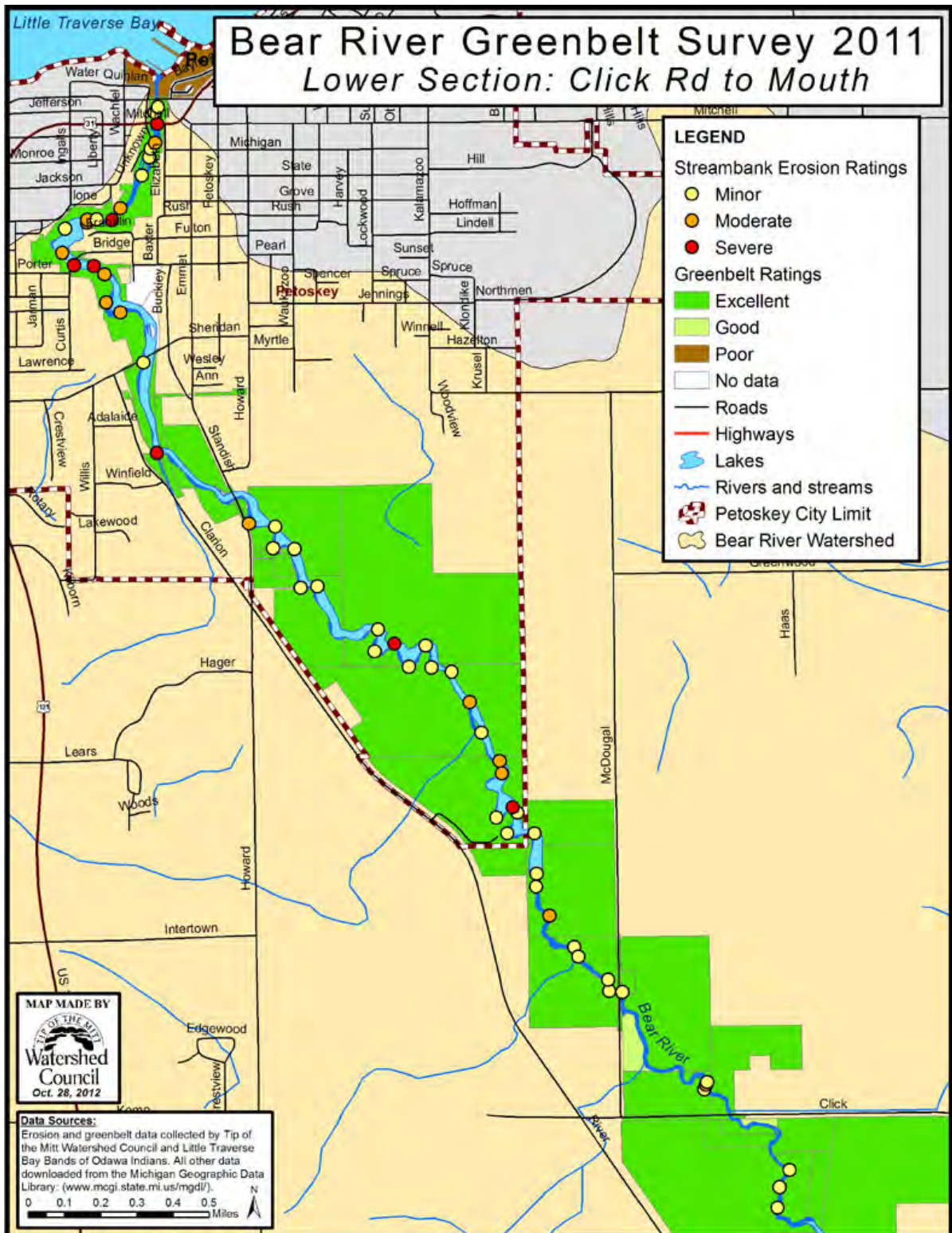
*\*Ratings based on the type, extent, stability, and slope of the eroded area.*

Harmful invasive species were documented on 20 riverfront properties. The most commonly found invasive species was purple loosestrife, which was found on 16 properties throughout the length of the river. The other harmful invasive species were found in the lower section of the river, between Click Road and Little Traverse Bay. Japanese knotweed was found on two properties, and invasive *Phragmites*, invasive buckthorn and black swallowwort were each found on one property.





**Figure 3.** Bear River greenbelt and erosion survey results.



**Figure 4.** Bear River greenbelt and erosion survey results: lower section.



## DISCUSSION

The 2011 survey results showed the majority of the riparian corridor along the main branch of the Bear River to be in excellent condition, with little evidence of human impacts. Greenbelts were found to be in great shape throughout the length of the river, the occurrence of invasive species was limited, and streambank erosion was generally found to be minor and attributable to normal river system processes. Extensive public land along the main branch of the river undoubtedly plays a role in maintaining the healthy riparian corridor observed during the survey. In addition, development within riparian areas is limited due to extensive riverine wetlands throughout much of the watershed (Figure 2).

Although most of the Bear River is in excellent health, human impacts are evident and contributing to some degree of water quality degradation. Poor greenbelts as well as nearly all instances of eroded streambanks were documented in the lower section of the river (from Click Road downstream) where development is concentrated. Flowing through the City of Petoskey, the lower section of the river is subject to a number of stressors associated with urbanization, such as stormwater runoff and recreational access and use. Flashy and high flows brought on by impervious surfaces, compacted paths along the river edge, the removal of riparian vegetation to facilitate river access, and other factors contribute to streambank erosion and greenbelt loss. However, it is important to keep in mind that high flow velocities in the channel caused by increased slopes in the lower section of the river naturally lead to streambank erosion.

Invasive species, including the purple loosestrife, were observed throughout the length of the Bear River from Walloon Lake to Little Traverse Bay. Occurrences of the other harmful invasive species of concern, invasive *Phragmites*, invasive buckthorn, and Japanese knotweed, were concentrated in the lower section of the river (from Click Rd downstream). Greater human population pressure in the lower section of the river is implicated in the spread of these invasive species.

Considering the excellent condition of the Bear River, measures should be taken to address existing problems and protect the river's water quality. One of the most effective tools for protecting the Bear River is education. Through information and education efforts that focus on the importance of maintaining a healthy greenbelt, addressing or preventing erosion, and controlling invasive species, Bear River waterfront property owners will become better stewards. In addition, local governments should be engaged and encouraged to assist with restoration, protection, and education efforts.

Regulation is another effective approach for protecting the greenbelts of lakes and streams. The main branch of the Bear River flows through Melrose Township in Charlevoix County, Bear Creek Township in Emmet County, and through the City of

Petoskey in its lower section. According to the Charlevoix County Local Ordinance Gaps Analysis (TOMWC, 2011), Melrose Township has adequate ordinances in place to protect greenbelts on water bodies. Bear Creek Township falls under Emmet County zoning, which requires a minimum 40-foot greenbelt buffer in scenic districts, which includes the Bear River. Zoning for the City of Petoskey lacks any provision to protect lakeshore and streambank greenbelts. The Bear River survey results show that all poor greenbelts and severe streambank erosion occurred in the City of Petoskey. Thus, in terms of regulation, greenbelts along the Bear River would benefit most from passage of a protective greenbelt ordinance in the City of Petoskey.

Despite the prevalence of healthy greenbelts on the Bear River, there is room for improvement. Parcels with compromised greenbelts generally had mowed turf grass to the river's edge. Although turf does constitute vegetation along the river bank, it does not provide the same benefits as a diverse, dense greenbelt. Turf grass has short roots compared with the extensive root system of native plants, shrubs, and trees, which results in a lesser capacity to filter contaminants from stormwater runoff and stabilize the streambank against erosion. Maintaining turf grass often requires the addition of fertilizers and herbicides, which invariably wash into the river. In addition, turf grass does not contribute habitat structure (e.g. branches), shade, and food energy (e.g. leaves) to the stream ecosystem. Therefore, the negative impacts associated with riparian vegetation removal and turf grass installation on riverfront parcels could be moderated by establishing a no-mow buffer zone or restoring native vegetation by planting herbaceous and woody plants.

The eroding streambanks documented during this survey are contributing sediments and nutrients to the river. Most areas exhibiting severe or moderate erosion could be remediated without incurring excessive costs. Bioengineering, or soft engineering, techniques can stabilize streambanks while also enhancing habitat.

Negative impacts to the Bear River associated with human activity could potentially increase as development expands in the greater Petoskey area. Riverfront properties could be further developed and recreational use and access to the river will likely increase. Increased population pressure could result in increased streambank erosion, a greater degree of riparian vegetation loss, and the further spread of invasive species. Thus, it is important to continually monitor the river and take action to address or prevent problems.

Two of three local governments in the project area have taken the lead by establishing a regulatory framework (i.e., passing ordinances) to protect shoreline and streambank vegetation. The information collected during this survey provides valuable baseline information for assessing the effectiveness of greenbelt protection ordinances, while also providing insight into the status of greenbelts along the main branch of the Bear



River. By sharing the river's overall greenbelt status with the public and providing outreach and technical help to riverfront property owners, this survey has the potential to protect and improve greenbelts on the Bear River, as well as those on other area streams.

### **Recommendations:**

The full value of this survey will only be achieved when the information is used to educate riparian property owners about the importance of shoreline vegetation, and encourage them to preserve, maintain, establish, or enhance their greenbelts. The following are recommended follow-up actions:

1. **Disseminate results of the survey.** The results of this survey should be shared with the public and in particular, with Bear River riverfront property owners. Publicizing the results will 1) raise the level of awareness of the overall condition of the Bear River riparian corridor; 2) increase public appreciation of the ecological value of streambank vegetation, thereby fostering greater stewardship of greenbelts, and the river ecosystem in general; and 3) help riparian owners better understand the value of ordinances. A summary of survey results should be sent to all riverfront property owners on the Bear River. Survey results can also be shared through other means, such as newspapers.
2. **Utilize the Internet to share survey information.** A general summary of the greenbelt survey and the full report should be posted on the LTBB and TOMWC web sites. Property-specific information can also be shared via these web pages by randomizing the shoreline survey database and providing property owners with a code number that refers specifically to survey results from their property. Posting the summary and report on the web sites of local governments is also recommended.
3. **Reach out to property owners with poor greenbelts.** Inform owners of properties that received poor greenbelt scores of specific results for their property. Supply these property owners with information (e.g. printed brochures) regarding the benefits of greenbelts and guidance for improvements. Encourage property owners to establish or improve greenbelts using a variety of native plants. Inform property owners that LTBB and TOMWC can assist with site assessments, as well as coordinate and implement greenbelt development or improvement projects.
4. **Educate and inform Bear River riparians and the public.** Collaboratively plan and implement an information and education campaign to increase awareness of the importance of maintaining a healthy riverfront. The campaign should: 1) encourage riverfront property owners to preserve or create healthy greenbelts

along as much streambank as possible, to the greatest depth possible, with various levels of vertical plant structure (overstory, understory, groundcover); appropriate plant density, and species diversity; 2) discourage riverfront alterations, such as seawalls and over-sized riprap, and promote natural streambanks bioengineering techniques; and 3) discourage the use of turf grass on or near the river's edge and the removal of emergent aquatic vegetation. The campaign can be accomplished through a variety of means, including mailings, newsletters, newspapers, and the Internet, but should also include informational meetings and workshops. Workshops should provide information about greenbelts and survey results, as well as a hands-on component where participants learn how to create and enhance greenbelts.

5. **Correct severe and moderate erosion.** Most areas with eroding streambanks that are contributing sediments and nutrients to the river could be remediated without incurring excessive costs. Determine appropriate funding sources, acquire funding, and implement projects that address the worst areas of streambank erosion.
6. **Control the spread of invasive species.** Controlling the spread of most of the harmful invasive species documented during the survey can be done effectively and affordably because occurrences are limited. Acquire funding and coordinate treatment of the harmful invasive species. Prioritize control efforts to focus on the invasive *Phragmites*, invasive buckthorn, black swallowwort, and Japanese knotweed infestations documented during this survey. Efforts to control purple loosestrife should also be undertaken, using biological control in heavily infested areas and manual removal and/or selective herbicide application in lightly infested areas.
7. **Get other local governments on board.** Promote the apparent success of ordinances that protect greenbelts with other local governments. In particular, the City of Petoskey should be encouraged to adopt an adequate greenbelt protection ordinance. Survey results may encourage local governments beyond the Bear River to pass greenbelt ordinances and thereby, help protect surface waters throughout the region.
8. **Repeat survey on a regular basis.** The river's edge changes continually, both in terms of physical characteristics and land ownership. Therefore, some version of this survey should be repeated regularly (ideally every 3-5 years), coupled with follow-up activities to promote greenbelt awareness and good management practices on an ongoing basis. Repeating the survey periodically will also help detect ordinance violations and ensure that any information used for ordinance enforcement is current.

## LITERATURE AND DATA REFERENCED

Charlevoix County GIS Office. 2004. Charlevoix County Digital Orthophotography. Charlevoix, MI. <http://www.charlevoixcounty.org/>

Charlevoix County GIS Office. 2010. Charlevoix County GIS Parcel Data. Charlevoix, MI. <http://www.charlevoixcounty.org/>

Emmet County Equalization/GIS. 2008. Emmet County Digital Orthophotography. Petoskey, MI. <http://www.emmetcounty.org/>

Emmet County Equalization/GIS. 2011. Emmet County GIS Parcel Data. Petoskey, MI. <http://www.emmetcounty.org/>

Michigan Geographic Data Library. 2012. Michigan Geographic Data. Michigan Department of Information Technology, Center for Geographic Information. Lansing, MI. <http://www.mcgi.state.mi.us/mgdl/>

National Oceanic and Atmospheric Administration (NOAA). 2011. Coastal Great Lakes Land Cover Project. NOAA Coastal Services Center. Charleston, SC. <http://www.csc.noaa.gov/crs/lca/greatlakes.html>

Tip of the Mitt Watershed Council. 2005. Little Traverse Bay Watershed Protection Plan. Tip of the Mitt Watershed Council. Petoskey, MI. <http://www.watershedcouncil.org/>

Tip of the Mitt Watershed Council. 2010. A Water Quality Summary of the Bear River. Tip of the Mitt Watershed Council. Petoskey, MI. <http://www.watershedcouncil.org/>

Tip of the Mitt Watershed Council. 2010. Control and Management of Purple Loosestrife (*Lythrum salicaria*) and *Phragmites* (*Phragmites australis*) in the Bear River Watershed. Tip of the Mitt Watershed Council. Petoskey, MI. <http://www.watershedcouncil.org/>

Tip of the Mitt Watershed Council. 2011. Charlevoix County Local Ordinance Gaps Analysis. Tip of the Mitt Watershed Council. Petoskey, MI. <http://www.watershedcouncil.org/>

Tip of the Mitt Watershed Council. 2010. Comprehensive Water Quality Monitoring Program Data. Tip of the Mitt Watershed Council. Petoskey, MI. <http://www.watershedcouncil.org/Protect/>

## Appendix A: Streambank erosion assessment field form

Stream Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 Site Number: \_\_\_\_\_ Recorder's Name: \_\_\_\_\_  
 Other Volunteers: \_\_\_\_\_

### LOCATION:

Name of County and Township: \_\_\_\_\_  
 Township Number: \_\_\_\_\_ Range: \_\_\_\_\_ Section(s): \_\_\_\_\_  
 Owner (circle one): **FEDERAL** **STATE** **COUNTY** **TOWNSHIP** **PRIVATE** **OTHER**  
 Nearest Road-Stream Crossing: \_\_\_\_\_  
 Other Information Regarding Location: \_\_\_\_\_

### SITE INFORMATION:

Bank-as designated while looking downstream (circle one) **RIGHT** **LEFT** (Also mark the appropriate side of the site on the map)  
 Is the site accessible by road for rock and equipment? (circle one) **YES** **NO**  
**IF NO-** Distance from the nearest road (estimate): \_\_\_\_\_

### CONDITION OF THE BANK (circle):

**A.** Toe is undercutting      **B.** Toe is stable; upper bank eroding      **C.** Toe and upper bank are eroding  
**D.** The percent of vegetative cover on the bank is (circle one): **0-10%**      **11-50%**      **51-100%**  
**E.** Problem trend (circle one): **INCREASING**      **DECREASING** (annuals growing)      **STABLE**  
**F.** Other (describe): \_\_\_\_\_

### APPARENT CAUSE OF BANK EROSION (circle all that apply):

**A.** Obstruction in river      **B.** Bend in river      **C.** Bank seepage  
**D.** Gullyng of bank from side channels. **E.** Type of foot traffic: \_\_\_\_\_  
**F.** Other: \_\_\_\_\_

### AMOUNT OF EROSION AND SLOPE RATIO:

**A.** Sideslope of bank-vertical (circle one): **1 :1**      **2:1**      **3:1**      **4:1 or flatter**  
**B.** Length of eroded bank (estimate/measured feet): \_\_\_\_\_  
**C.** Average height of eroded bank: \_\_\_\_\_

### RIVER CONDITIONS:

**A.** Approximate width of river where erosion occurs (feet): \_\_\_\_\_  
**B.** Approximate depth of river: \_\_\_\_\_ at \_\_\_\_\_ feet from the bank. (Preferably get estimate 4' from the bank)  
**C.** Current (circle one): **FAST**      **SLOW**  
**D.** Soil Texture (circle): **SAND**      **CLAY**      **LOAM**      **GRAVEL**      **STRATIFIED**      **SAND OVER CLAY**  
 Other Textures: \_\_\_\_\_

### TYPE OF TREATMENT RECOMMENDED (circle):

**A.** Rock RipRap   **B.** Log Jam Structure      **C.** Obstruction Removal      **D.** Bank Sloping  
**E.** Stairways      **F.** Bank Seeding or Planting      **G.** Brush Placement      **H.** Fencing  
**I.** Other (explain): \_\_\_\_\_  
 \_\_\_\_\_